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ABSTRACT

This paper discusses Piaget's constructivist theory of logico-mathematical knowledge, the development of knowledge in children, and implications for preschool activities. The theory that a child cannot understand anything she or he has not constructed is advanced. Contrasts between Piaget's theory and the theories of Gibson and Luria are described briefly. It is proposed that although language plays a role in logical thought, it is itself insufficient to account for the development of cognizance (conscious knowledge). The development of knowledge is discussed in terms of the concept of object permanence, the ability to understand how things can be transformed and the ability to construct relatedness through inference. Piaget terms this inferential process logico-mathematical knowledge. The role of action in the development of logico-mathematical knowledge has implications for preschool program content. Three problems with which young children characteristically have difficulty are discussed: (1) the problem of gaps (inferring continuity in the face of discontinuity); (2) the problem of representation (reflecting on the form of movement); and (3) the problem of procedures (relating static states to the transformation that produced them). Ways of encouraging development in these areas are presented in examples from the School for Constructive Play at the University of Massachusetts. Also discussed are new teaching techniques defined by Inhelder, Sinclair and Bovet that are based on a predict-observe-predict paradigm consistent with constructivism. (SB)

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The Implications of Piaget's Constructivism for Early Childhood Education

George E. Forman[1]

What is the construction in Piaget's constructivism? Piaget maintains that we cannot understand anything that we ourselves have not constructed. This axiom has corollaries about the definition and the source of knowledge. Constructivism has been criticized, but the criticism comes from a confusion over the definition of knowledge and a simplistic view regarding the source of knowledge.

To Piaget, knowledge is consciousness of the procedures by which we make conclusions. Knowing is more than doing, even though doing is the source of knowing. Knowing is representing the doing as a general structure. The structure itself becomes the object of knowing. The construction of knowledge is a process of making explicit the structure of performance, and later in development, the structure of thought itself.

James Gibson has criticized constructivist theories of perception. He maintains that we have ignored the immense amount of information that is in the environment, information which our peripheral sensory systems are designed to pick up rather automatically. Gibson's work does not indict Piaget's constructivism for two reasons. Gibson's work deals with continuous stimulus events; Piaget's work deals with discontinuous events. Gibson's theory pertains to our automatic pick up of sensory information or RESONANCE;

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Piaget's theory pertains to our gradual awareness of how we know or COGNIZANCE.

Piaget is well aware of the sophistication of our biological equipment as active systems. The perceptual systems set adaptive constraints on action, the form of action sets adaptive constraints on structures used for knowing. Piaget's knowing is more than Gibson's looking, but both are more than naive theories of passive seeing -- as we will see.

What about the sources of knowledge? Piaget has identified several sources, but emphasizes their interaction rather than their independent effects. Knowledge can be constructed from information that comes from others, from objects, and from a reflection on our actions per se. Other theories seem to emphasize one source over the other. Let's look at Luria's work as an example.

Luria makes a strong claim that modes of knowing are a product of the practical activities of the culture. The agrarian serf of Russia classifies objects on the basis of functional and situational dimensions (e.g., axes and wood are both tools, since "you need them both when making handles."). Post revolutionary workers who have organized collectives and who have institutionalized instruction classify on the oasis of abstract definitions (e.g., hammers and axes are tools "because they are both used to make things."). Luria concludes that the shift from serf to cell has caused a shift from situation-bound to abstract modes of thinking.

At first glance Luria's work seems to contradict Piaget's emphasis on the biological origins of cognitive development. A close reading of Piaget's Biology and Knowledge (1971) removes this apparent contradiction. Piaget's work relates to how it is that abstract thought is possible at all, not why it does or does not occur in one particular social setting.

Luria is interested in efficient cause -- the motivation of cognitive development; Piaget with formal cause -- the invariant course of cognitive development. Source to Luria means force; source to Piaget means origin. The shift from feudal serfs to organized collectives itself was possible only because we humans have the competence to deal with complex relations. New complexities are constructed out of old complexities. Old complexities are the origins of the new. Piaget states that the person cannot be given a new structure, be it linguistic or political. The new structure must be assimilated, the old accommodated, to create a useful intellectual structure, a structure that does not function as an automatism. To say that culture is the source of modes of knowing begs the question of how culture can change in the first place. In like form, to say that language is the source of logical thought begs the question of how the child develops to a point where he can profit from an interaction with speaking adults.

Language is important, but insufficient to account for the development of conscious knowledge. Does knowledge from objects explain knowing more completely? The child can explore objects and discover their rigidity, texture, curvature, and color. However sensory explorations alone will never lead to a conclusion that objects are permanent. Permanence must span discontinuous stimulus events: object seen, object not seen, object seen. We can't say "object hidden." "Hidden" is a complex inference. Object permanence is not in the ambient light. True, the child may smile in recognition of the second sighting of the object, but will the child search for the object when it is hidden from view.

The search has profound implications. To use Piaget's term, searching implies that the child has <u>closed</u> the structure of the movements of self and object. The child has done more than recognize the physical

similarity between two citings. The child has done more than distinguish self movement from object movement. He has coordinated these events into a closed structure. The closed structure is the source of the conclusion that the object is still in space, albeit behind a screen. He knows that the object still exists, that is, he has constructed space. The structural closure of these respective movements results from autoregulatory processes. These processes are endogeneous to the organism and cannot themselves be learned. They are part of what it means to be Homosapien. Regular patterns of peek-a-boo no matter how frequent or contingent are insufficient to account for the construction of space as something known as a place in which the child himself can be just another object.

With further development the child comes to understand how things can be transformed, how to make the object reappear, what procedure was used to transform the shape of the clay, or what procedures maintain the equivance between original and transformed states. Initially states are understood as static and discrete. The child must construct their relatedness by inference. Piaget terms this inferential process logico-mathematical knowledge. With development logico-mathematical knowledge becomes more conscious, more an object of thought and thereby more capable of being a tool for thinking. Logico-mathematical knowledge closes the structure of object permanence, closes the inference of cause and effect, and closes the syllogism of propositional logic. Nevertheless, logico-mathematical knowledge comes neither from objects or others alone. Their primary source comes from our endigenous competence to relate successive actions into a total form independent of effects. Action has a form as well as a cause-effect content. Piaget's attention to the form of action is one of his most important contributions to epistemology.

Action can be back and forth, in and out, together and apart, away from and toward. Once the child begins to think about the relation of two actions he is on his way to the construction of abstract thought, thought that deals with logical relations rather than merely contingent reoccurences. The shift from functional-situational modes of thought to abstract thought may be motivated by the social press, but it has its origin in the universal competence of our specie to reflect on the form of two successive actions. Consider the shift from spatial relations to taxonomic relations. The tail is a spatial part of the whole alligator. The alligator is a taxonomic member of the class reptiles. A tail is only a tail, but an alligator is also a reptile. The also in that sentence refers to the dual "position" of the alligator; but this is not a spatial position. The transcendence of time and space results from closing the structure, a structure that simultaneously relates "movements" in two directions. Being in two positions at once (that is, two categories) is the essence of the logical, non-causal relation. The child constructs this structure out of real movements by reflection on their form. Form is frozen movement. Language is necessary to extract time from movement, but cannot itself be the origin of the form.

Do the details of Piaget's constructivism carry any implications for educational practice? Piaget has identified important intellectual achievements accomplished by the child between the second and seventh years of life. His work definitely has implications for early childhood education. I see two broad areas of application: one, the content of the preschool program, and two, the techniques of teaching young children.

Program content can be defined by the problems with which young children characteristically have difficulty. I will mention three. One, infering continuity in the face of discontinuity, or the problem of gaps.

Two, reflecting on the form of movement, or the problem of representation. Three, relating static states to the transformations that produced them, or the problem of procedures. During the age from two to seven the child is busily constructing representations of procedures so that she can understand the gaps in discontinuous events.

Does a bite from this piece of cake taste as good as my neighbor's piece which came from the same cake? Why does pulling down on the pulley rope make the basket go up when I want it to come down? How can this butterfly ever have been that caterpillar? These problems exist because the child cannot coordinate the elements of the relation. She views them as discontinuous, discrete events. Once two pieces of cake are separated from each other the young child finds it difficult to think that both pieces came from the same whole. The child cannot understand how two spans of rope can be part of the same rope if pulling down on one leads to an opposite effect in the other. A butterfly that once was a caterpillar is as incredulous to the three year old as your acceptance of the fact that I am simultaneously a person and a whopper burger.

Snow was once water. Mother still loves you even when she is low. Two is greater than one but less than three. Your wishes are not automatically known by others. These are all forms of discontinuities, either actual or phenomenal, with which the young child must deal.

This brings us to the problem of procedures, relating states to transformations. The construction of the procedures by which one state changes into another is not a simple matter of reading from the environment. Often the transformation must be inferred. Here is an example. Kevin and his teacher were making imprints in rolled out dough. Both Kevin and his teacher had identical objects, a hollow plastic cylinder. Kevin makes

a rectangular imprint with the side of his cylinder. The teacher takes her cylinder, rotates it, and presses the top into the dough making a circle. Kevin stops what he is doing, looks enviously at the circle, then grabs the teacher's cylinder so that he too can make circles. The circle he makes seems to be an accident of his grip. Of course, he could have made a circle with his own cylinder. But that would have required an inference, to wit: since our objects are alike the circle resulted from a transformation of the object. Kevin only saw that the teacher's toy, as a static state, lead to the circle design, a subsequent state. Grabbing and possessiveness, common traits in two and three year olds, might be explained by the children's failure to understand that one object is often just as good as another, as long as the object in hand is properly transformed.

At the School for Constructive Play, a Piagetian preschool at the University of Massachusetts, we have a slogan. Change Without Exchange. We encourage the child to change the object rather than exchange it for a new one. Preschool education needs to give the child control over the procedures by which different effects are created with the same object. At our school we have wagons that the child can change from waddle to rock, hollow balls that the child can change from light to heavy. By focusing on within-object changes rather than between object exchanges children may more likely form a Galilean world view of process rather than an Aristotelian world view of discrete categories (see Elkind, 1969).[2] Perhaps early education can prepare the child to apply within-object change to between-object

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[2]Elkind, D. Conservation and concept formation. In E. Elkind & J. Flavell (Ed.), Studies in Cognitive Development. New York: Oxford University Press, 1969, pp. 171-189.

differences later in his school career, such as understanding the continuity between man and ape, or between us and them.

This brings us to the problem of representation. Representation is essential for filling the gaps. Gestures, graphics, and language all assist the child to span the discontinuous and to identify the shape of change.

At the School for Constructive Play we encourage children to make graphic representations of motion itself. Seth rolls a plastic spool down an incline; the spool makes paint blips as it rolls. An I.V. tube filled with colored water is suspended from the ceiling making a steady drip in the sand. As Amy moves the tip of the tube quickly she notices that the spots are far apart. When she moves the tube more slowly, the spots are closer together. A teacher wets a section of the sidewalk so the children can notice their tricycle tracks. These games and media, we feel, help children freeze movement so that they can study the form of the action. As one tricycle buff exclaimed after making a reverse direction with one wet wheel "Look, I made the letter Y!"

Our teachers use language that emphasizes the action. We shy away from the question "What is this?" and seek opportunities to ask "How did you do that?" More often we parallel play and make simple declarative sentences such as "Jenny is pressing her clay, now she is stretching it out." Words, like graphics, can atemporalize the movement. The word stands for the entire procedure. The contraction of the procedure makes it easier for the child to coordinate one state with its origin. Coordinating a state with its origin is no less than a dynamic understanding of the present state.

Let's move quickly to techniques of teaching. Constructivism is a theory of how knowledge depends on endogeneous activity. Is it, therefore, only a theory of self-education? Can we look to constructivism for guidelines

for teaching techniques? If we accept the leap from Is to Ought, how can we best preserve the child's natural construction of knowledge?

In a 1974 publication Inhelder, Sinclair, and Bovet[3] define exciting new techniques of teaching, techniques that are consistent with constructivism. The basic paradigm is as follows. The child is never given answers verbally. He is presented questions which cause him to repeatedly contradict his own previous prediction about the outcome of the same event. For example, equal quantities of water in identically shaped glasses are simultaneously drained into two glasses grossly different in shape; then these two galsses are drained into indentically shaped glasses. After changing his predictions regarding the two water levels, only to find the new prediction disconfirmed as well, the student begins to rethink the reasoning behind his answers. He somehow feels that the world itself could not be that caprious. These games are designed to pit an advanced mode of reasoning ("It's the same water") against a less advanced mode ("It's the same amount of water."). The conflict eventually causes the child to assimilate the less advanced mode into the more advanced mode, which has the additional effect of elaborating the more advanced mode, i.e., accommodation occurs also.

Piaget, in the preface to this work, points out that this model of learning is quite different from either response shaping due to external reinforcement or stimulus discrimination due to selective feedback. We have here a case of constructive assimilation which cannot be accounted for by principles of generalization or differentiation alone. An implicative closure occurs where parts of the structure explain other parts. The higher

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[3]Inhelder, B., Sinclair, H. & Bovet, M. Learning and the Development of Cognition. Cambridge: Harvard University Press, 1974.

mode of thought (conservation of identity) closes with the lower mode of thought (conservation of quantity). The closure explains the illusory differences in amount. To Piaget, knowledge is more than ignoring misleading cues, like water levels. Knowledge is knowing why those cues are misleading. Knowledge is a matter of understanding what you see, not a decision to selectively ignore.

The Predict-Observe-Predict paradigm is general enough to be used with young children, even though we do not often ask young children to make a verbal prediction. The teacher puts an off-sized wheel on an axle. Can the child negate the teacher's transformation to recreate straight rolling wheels. Or can he make some reciprocal adjustment in the position of the ten pins to accommodate the arcing path of the wheels. The conflict staged by the teacher can eventually cause the child to consider the relation between structure and function and thereby make predictions which are confirmed. At the School for Constructive Play the teacher's role is trouble maker, albeit a sensitive trouble maker. The staging of conflict, judiciously dispensed, is a teaching technique that is consonant with Piaget's constructivism. Conflict comes from a clash of ideas and it is only through rethinking that the clash will be resolved. This rethinking is an endogenous, self-regulated process that draws from previous sensory-motor schemes, and which themselves draw from biological schemes. Conflict resolution is more likely to preserve the continuity between biology and knowledge, at least knowledge as conscious understanding.

After all of this, I hope <u>you</u> are both conscious and understanding.

Thank you.